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ABSTRACT

This study investigated whether infants who were given increased amounts of response-contingent stimulation would evidence positive and nonspecific transfer of learning to situations requiring new responses to control environmental events. Subjects were thirty 3-month-old biologically normal home-reared infants. Infants in the group assigned to a contingent stimulation treatment received 4-second presentations of a cartoon movie plus music contingent on non-issy vocal responses. Infants in a noncontingent stimulation group received the same temporal pattern of auditory visual stimulation that had been presented to the contingent group. A control group received no stimulation. Both immediately prior to and following treatment all infants were brought to the laboratory for a visual conditioning session. Delayed posttests were given after two weeks to determine if the effects would persist. Results showed that both the contingent and non-contingent stimulation procedures enhanced subsequent learning. (MS)

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The Effects of Responsive Stimulation in Early Infancy

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Recent research findings indicate that the responsiveness of an infant's environment is correlated positively with measures of cognitive performance. For example, Lewis and Goldberg (1969) reported that the amount of contingent stimulation that mothers provided to their infants was positively related to the infant's performance in an habituation paradigm. Watson (1971) reported evidence for transfer of learning in very young infants. More recently Ramey, Heiger and Klisz (1972) and Ramey, Starr, Pallas, Whitten and Reed (1975) have demonstrated that increasing the amount of response-contingent stimulation for developmentally delayed infants was associated with general developmental advance as measured by standardized tests of infant development and by performance on a free operant learning task. However, cause-effect statements concerning responsive environments and subsequent performance by infants must be tempered by two major limitations. First, the studies which have linked maternal responsiveness to infant behavior have been correlational rather than experimental in nature (e.g., Lewis and Goldberg, 1969). Second, earlier experimental studies tended to use diffuse treatment conditions (Ramey et al., 1975) or to deal with samples of children that might not be typical of normal infants (Ramey et al., 1972; Ramey et al., 1975).

To increase the generality of previous experimental studies, Finkelstein and Ramey (in press) conducted a series of three laboratory experiments. The experiments demonstrated that normal infants between the ages of 6 and 10 months who were given increased amounts of response-contingent stimulation

in one free operant task showed enhanced learning in a second free operant task when compared to infants who had received either noncontingent-stimulation or no additional stimulation in the first situation. Although this study was successful in demonstrating a positive and nonspecific transfer of learning in infants, it did not address the issue of whether transfer would occur when the treatment was applied in a nonlaboratory setting and whether there was transfer across different settings. In essence, the question is whether the phenomenon of nonspecific transfer occurs only when the treatment and transfer situations are very similar or if it occurs in a more generalizable fashion. Thus, the present experiment was conducted to determine the effects of response-contingent stimulation on subsequent learning performance with biologically normal, home-reared infants who were already presumably capable of instrumental responding in the species typical normal environment.

The specific question addressed by this experiment was whether infants who were given increased amounts of response-contingent stimulation would evidence positive and nonspecific transfer of learning to situations requiring new responses to control environmental events. The response systems chosen for this experiment were ones which have previously been used to demonstrate instrumental learning in infants. The responses were nonfussy vocalizations which have been conditioned by a number of investigators including Ramey and Ourth (1971) and visual fixations which were shown to be conditionable by Watson (1967).

Methods of Procedure

Subjects

Thirty, 3-month-old, biologically normal infants were selected to participate in this experiment which used a pretest-differing treatments-

immediate posttest-delayed posttest design. Infants were recruited from county birth records. Parents were contacted to secure participation in the study until 20 infants were included in the sample. Because the study involved home visits, infants whose mothers worked full time outside the home could not participate in the study. Triads were formed and one infant in the triad was randomly assigned to each of 3 treatment groups: contingent stimulation, noncontingent stimulation, and no additional stimulation.

Home Vocal Conditioning Treatment Sessions

Apparatus. The apparatus brought into the homes for vocal conditioning sessions included: two Sony cassette decks (Model TC 129) specifically modified so that their right tracks could be used as four channel systems for recording or play-back of electronic signals, a Kodak Moviedeck, (Model 465) mounted on a stand with a shutter directly in front of the projector's lens, and a plexiglass screen mounted in a wooden frame along with an audiospeaker.

Baseline Procedure. Each day a female experimenter visited the infants' homes. During the first visit, the baseline rate of vocal responding was determined in a 15 minute session. The infant was placed in an infant seat approximately 45 cm from the screen, and his or her mother and the experimenter were situated behind and out of the infant's view.

The movie projector was turned on, but the shutter control was disconnected so that observations were made under comparable background noise conditions in each home visit. Each time the infant made a nonfussy vocal sound the experimenter depressed a button causing an electronic signal to be recorded on one channel of the cassette deck. For the next nine home visits, sessions lasted 10 minutes and three groups were treated differently as described below.

Contingent stimulation procedure. Infants in this group received 4-second presentations of a cartoon movie plus music contingent on nonfussy vocal responses. Vocal responses made during stimulation were scored but were not further rewarded. The experimenter depressed a button connected to the playback cassette deck to control the opening of the shutter and presentation of music. The button was also connected to the record cassette deck and when depressed caused an electronic signal to be recorded on this deck. The playback deck was connected to the record deck so that shutter openings and closing, and a copy of the music being played were automatically recorded on the latter cassette deck.

Noncontingent stimulation procedure. Infants in this group received the same temporal pattern of auditory-visual stimulation that had been presented to their triad mate in the contingent group. The cassette tape that had been recorded in a specific session (e.g., first) for the contingent child was played back to the noncontingent child in the latter's corresponding (e.g., first) session. Electronic signals on the right channel of the playback cassette deck controlled the presentation of noncontingent stimulation while the experimenter used the second cassette deck to record the occurrence of nonfussy vocal responses. Presentations of noncontingent stimulation were recorded automatically on the second cassette deck.

No additional stimulation. For infants in the no stimulation group, baseline procedures were continued for nine additional sessions. The occurrence of nonfussy vocalizations was coded using one cassette deck.

Pretreatment, Immediate and Delayed Posttreatment Visual Conditioning Sessions

Both immediately prior to and following treatment, all infants were brought to a laboratory where they participated in a visual conditioning session similar to one described by Watson (1967). A delayed posttest

was given 2 weeks after the immediate posttest to determine if the effects would persist after treatment was discontinued. A schematic drawing of the apparatus for this situation is presented in Figure 1. This part of the

 Insert Figure 1 about here

experiment began with the mother placing the child in a supine position into a form-fitting infant seat which prevented excessive lateral movement of the body. This seat was situated in a plexiglass test chamber measuring 60 cm high, 124 cm long, and 63 cm wide. The plexiglass chamber was mounted on a wooden frame. Contact paper was used on the outside of the chamber to eliminate distracting stimuli. From the interior of the chamber the infant could see only the white backing of the paper. A Panasonic video camera was positioned to allow viewing of the infant on a television monitor housed in an adjoining control room.

After the infant was in position, a shield containing two 90° angle viewing screens measured 17 cm X 12 cm with a separation of 20 cm between them. A Kodak 800 H projector fitted with a shutter over the lens was positioned outside the room so that it was capable of projecting an image on one or the other of the two telescreens through a window. Two projectors are depicted in Figure 1 to indicate the projector could be placed to illuminate either screen.

After the child was properly situated in the crib the mother moved away from the crib into the adjoining control room and out of the child's line of vision. The experimenters observed the infant from the adjacent room using the television monitor.

The session consisted of the following periods: 1 minute baseline, 6 minutes conditioning, 1 minute extinction, 2 minutes reconditioning and 1 minute re-extinction. Almost all infants completed the baseline and conditioning

periods in all 3 sessions. However, the attrition rate due to crying rose sharply for the extinction, reconditioning and reextinction periods. There was a sufficient sample size to analyze data only from the baseline and conditioning periods in each session. For both pretest and immediate posttests all 30 children completed the conditioning period. One child in the noncontingent group did not complete the conditioning period of the delayed posttest due to crying.

During conditioning periods each visual fixation on one randomly determined screen resulted in the delivery of visual reinforcement on what Ramey et al. (1972) have called a synchronous schedule of reinforcement. Under this procedure reinforcement commences with response onset and terminates with response offset. Visual fixation on the other screen did not result in reinforcement. The reinforcer in this situation was a chromatic slide of a stuffed toy animal.

Results

Treatment Phase

Vocal responses during home sessions were converted to per minute rates. In 5 of 300 home sessions the recorders fell out of adjustment and the observations could not be decoded. No infant had data missing for more than one session. The missing data points were estimated using a La Grangian linear interpolation procedure that did not alter existing data and provided estimates that were in accord with the existing data trend for the individual (see McCall, Appelbaum & Hogarty, 1973). Data from home sessions were blocked into a baseline session and 3 blocks of 3 treatment sessions. Figure 2 contains vocalization means for the three treatment groups during baseline and each block of 3 treatment sessions.

 Insert Figure 2 about here

A Group X Blocks repeated measures analysis was performed to test for differential change in vocal response rate across sessions. In order to avoid making assumptions about the structure of the variance-covariance matrix necessary for repeated measures analysis of variance, a multivariate analysis of variance approach to the analysis of repeated measures designs was employed (McCall & Appelbaum, 1973).

Linear, quadratic and cubic polynomial trend scores were computed from repeated measures data. Results indicated a reliable Groups X Blocks interaction $F_{\text{mult}}(6,50) = 2.22, p < .056$. Univariate tests showed a significant interaction only in the linear trend $F(2,27) = 3.95, p < .031$. Simple effects tests for blocks within groups revealed a reliable change across sessions only for the contingent group $F_{\text{mult}}(3,25) = 6.20, p < .003$. Again only this test of linear trend was significant $F(1,27) = 9.14, p < .005$.

As can be seen in Figure 2, only the group receiving contingent stimulation during home sessions increased their rate of vocal responding across sessions. Therefore, all groups performed as expected with only the contingent group showing evidence of instrumental learning.

Pretest and Posttest Visual Conditioning Performance

The dependent variable in this task was the seconds per minute spent looking at the positive (reinforced) screen minus the seconds per minute spent looking at the negative (not reinforced) screen. This difference score for the conditioning period was compared to performance during the baseline period in each session. Separate 3(groups) X 2(periods) repeated measures analyses of variance were performed for pretreatment immediate posttest sessions, and delayed posttest sessions.

The mean differences in seconds per minute for fixation to the positive screen in the pretreatment and immediate posttreatment sessions for the three treatment groups are presented in Figure 3. Data analysis

Insert Figure 3 about here

for the pretest session indicated that neither the main effects nor interaction were reliable.

A similar analysis was performed on the difference scores from the immediate posttreatment session. The Groups X Periods interaction was significant, $F(2,27) = 14.38$, $p < .001$. Simple main effects tests indicated that only the contingent and noncontingent treatment groups reliably increased the difference between looking time to positive and negative screens from baseline to conditioning periods. However, the mean increase in the difference score for the contingent treatment group (19.4 seconds per minute) was double that of the noncontingent treatment group (9.6 seconds per minute). The no additional stimulation treatment group showed almost no reliable change in the difference score (1.14 seconds per minute).

The analyses of the delayed posttest data indicated that there was no evidence of learning in any of the groups. Thus, the treatment effects were not maintained after the intervention ceased.

Discussion

The results of this study indicated that experience with contingent stimulation enhanced subsequent learning in a new test situation. This conclusion is based on a comparison of the contingent stimulation and no stimulation groups. Neither the contingent nor the no stimulation group showed any indication of learning in the visual fixation task during the pretest session. However, in the posttest session, the contingent stimulation group learned to fixate the reinforced screen, whereas, the no stimulation group did not. Thus, the infants receiving contingent stimulation showed an improvement in learning from pretest to immediate posttest which was not paralleled by infants who received no additional stimulation during the home treatment sessions.

The finding of enhanced learning following experience with contingent stimulation is not unique. In other studies, this same result was reported (Finkelstein and Ramey, in press). However, the fact that treatment and posttest sessions were held in strikingly dissimilar settings adds considerably to the generalizability of the effect. Previous studies had demonstrated that experience with contingent stimulation generalizes within the same setting across different responses and different reinforcing stimuli. In this study, it was found that contingent stimulation experience generalizes across different learning settings such as the infant's home and a laboratory in the research center.

It would seem from the data that experience with noncontingent stimulation also enhanced infant's learning. Infants receiving noncontingent stimulation did not learn the visual fixation response during the pretest but did acquire this response in the immediate posttest session. This result contradicts a number of earlier investigations of the effects of sustained experience with noncontingent stimulation (Watson and Ramey, 1972; Finkelstein and Ramey, in

press; Seligman and Maier, 1967; Thornton and Jacobs, 1971; Dweck and Repucci, 1972). One possible explanation for this result is that at age 3 months, noncontingent stimulation and contingent stimulation are equally facilitory of infant learning. That is, what's important is providing stimulation to infants and its responsiveness is not a determining factor in cognitive performance. On the other hand, this result could be explained by consideration of what mediates transfer after experience with contingent and noncontingent stimulation.

Earlier research (Finkelstein and Ramey, in press) led to the conclusion that transfer effects were mediated by changes in the children's attentional strategy. Figure 4 illustrates a model to explain the effects of contingent and noncontingent stimulation on transfer of learning.

Insert Figure 4 about here

There are two factors in this model which affect the relative strength of transfer. The first factor is the similarity of the context in which the treatment and transfer sessions are held. The context is defined by the physical surroundings, the response required, and the similarity of the reinforcing stimuli. As the treatment and transfer sessions become more dissimilar, the strength of the transfer decreases to 0. Thus, if the posttest session involves a very different physical setting, a very different or novel reinforcing stimulus and a very different response from the treatment session both positive and negative transfer would be absent. The second factor influencing transfer is an attentional strategy. It is assumed that children can pay exclusive attention to the stimuli presented by the setting including potentially reinforcing stimulation or they can pay exclusive attention to their own behavior. In between these extremes, children can distribute attention to both the stimulus and response aspects of the learning situation. It is hypothesized that experience

with noncontingent stimulation results in the adoption of a strategy of relatively unbalanced attention favoring the external stimulation. Finkelstein and Ramey (in press) have presented data consonant with this point. They demonstrated that children receiving noncontingent stimulation paid more attention to the stimulation than children who were receiving the same stimulation contingent upon lever responses. This tendency for children receiving noncontingent stimulation to attend more to the stimulation transferred to a panel press posttest situation. Although the difference was not reliable in the panel press posttest, children who previously received stimulation in noncontingent fashion paid more attention to the stimulation than children who had previously received the same stimulation in contingent fashion. These data suggest then that noncontingent stimulation fosters greater attention to stimulus presentation and it is possible that this strategy can transfer to new learning situations.

In contrast to the effect of noncontingent stimulation, it is hypothesized that experience with contingent stimulation leads to a more balanced distribution of attention to stimulus and response aspects of a learning situation. In the earlier study by Finkelstein and Ramey (in press), children who received contingent stimulation paid more attention to response performance as measured by visual fixation of the response manipulanda than did children who received noncontingent stimulation in treatment sessions. It was also observed in the post treatment transfer situation that children who previously received contingent stimulation tended to pay more attention to their response performance than children who had received noncontingent stimulation previously. Thus, it is argued that experience with contingent stimulation results in the adoption of a more balanced strategy whereas experience with noncontingent stimulation results in relatively exclusive attention to stimulus aspects of the situation. Further, it appears that these strategies transfer to new learning situations. The more similar the treatment and transfer situations are, the more strongly these strategies are probably

called forth. When treatment and posttest situations are extremely dissimilar, these strategies are not called forth and thus, transfer is not observed.

In the present study, the posttest response was essentially learning to pay attention to a stimulus. The nature of the synchronous schedule resulted in learning when children fixated a stimulus. Thus, children who received noncontingent stimulation possibly transferred a heightened attention to stimulation and hence showed evidence of learning to control stimulation when, in fact, there was no enhanced learning to control stimulus availability. In a sense, the explanation being advanced is that the apparent learning transfer of noncontingent subjects may have been an artifact of the response procedure chosen for the posttest in this study.

Nonetheless, it is clear from comparing the contingent stimulation and no stimulation groups that experience with contingent stimulation does enhance learning in new situations and that this enhancing effect generalizes across quite dissimilar situations.

Reference Note

- ¹ Watson, J. S. & Ramey, C. T. Reactions to response-contingent stimulation in early infancy. Paper presented at the meeting of the Society for Research in Child Development, Santa Monica, California, March, 1969.

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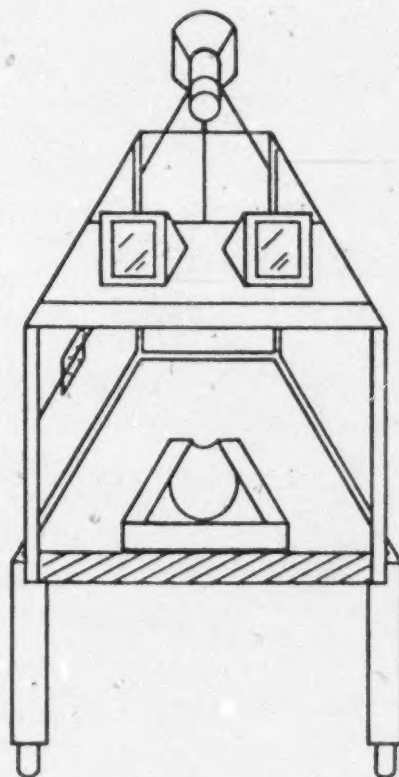
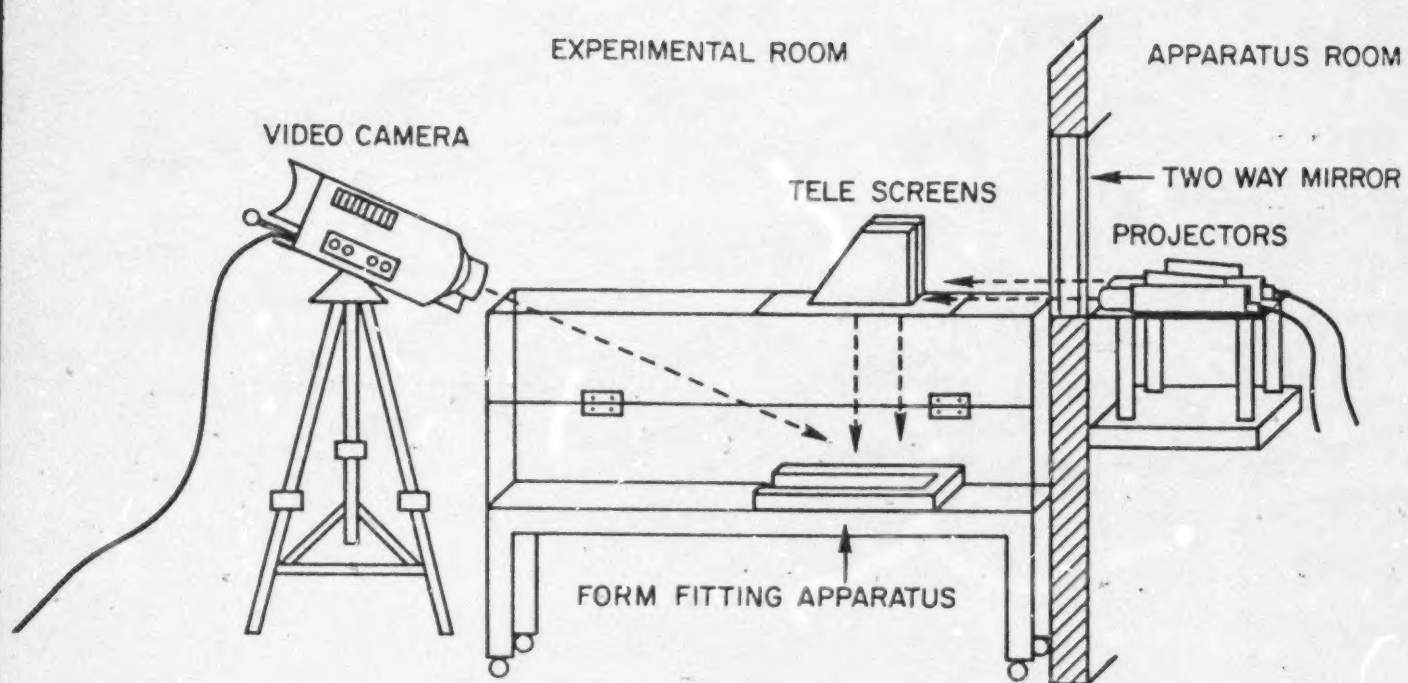
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FOOTNOTE

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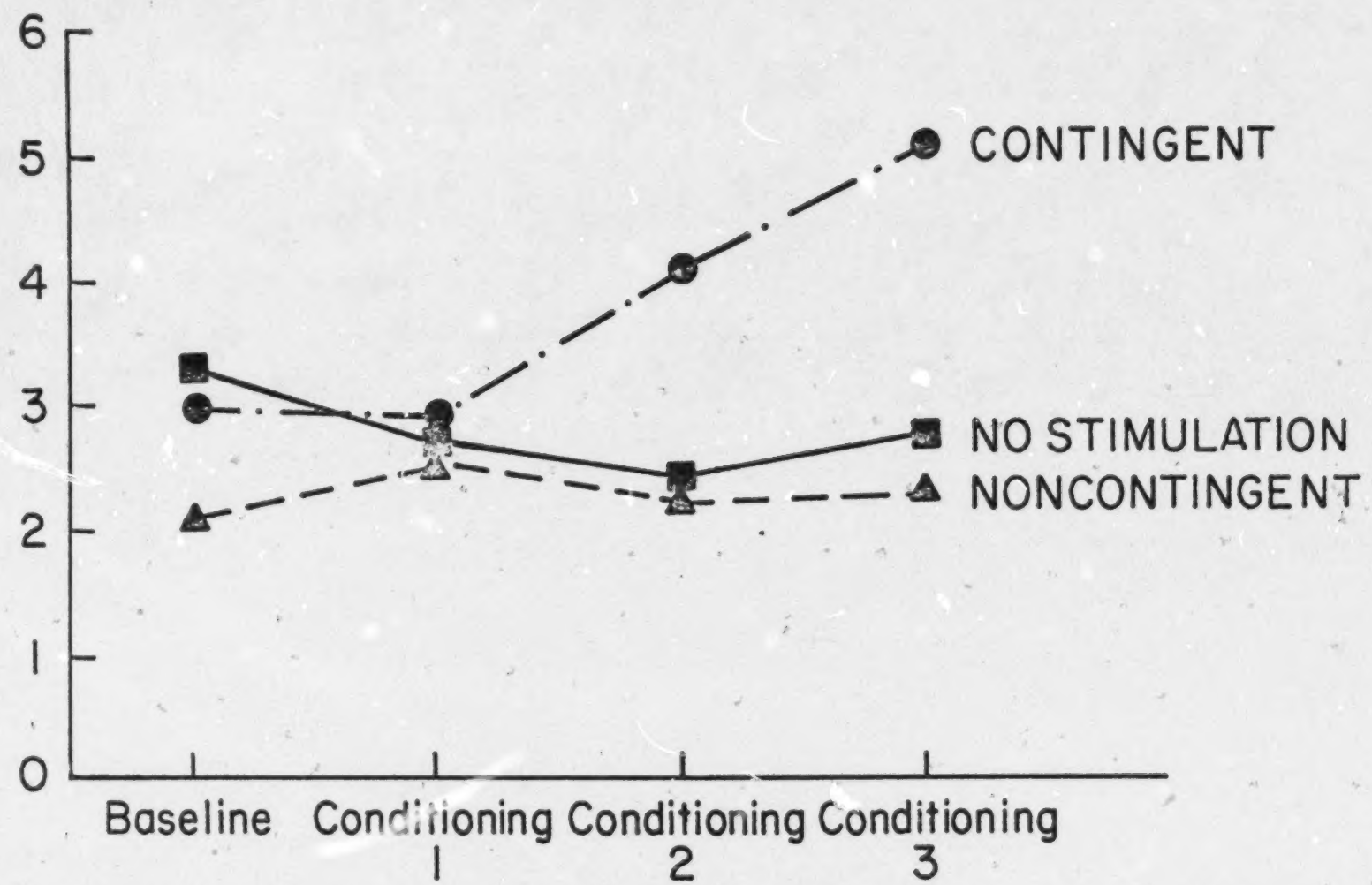
FIGURE CAPTIONS

- Figure 1. Apparatus for the visual conditioning situation
- Figure 2. Mean vocal responses for baseline and conditioning periods for three treatment groups
- Figure 3. Mean differences (in seconds) between visual fixation to the positive screen minus fixation to the negative screen for three treatment conditions
- Figure 4. A model for contingency transfer. Transfer is viewed as a function of similarity in treatment and transfer contexts and children's attentional strategy ($\bar{S}$ = attention to discriminative and reinforcing stimuli; R = attention to response performance).



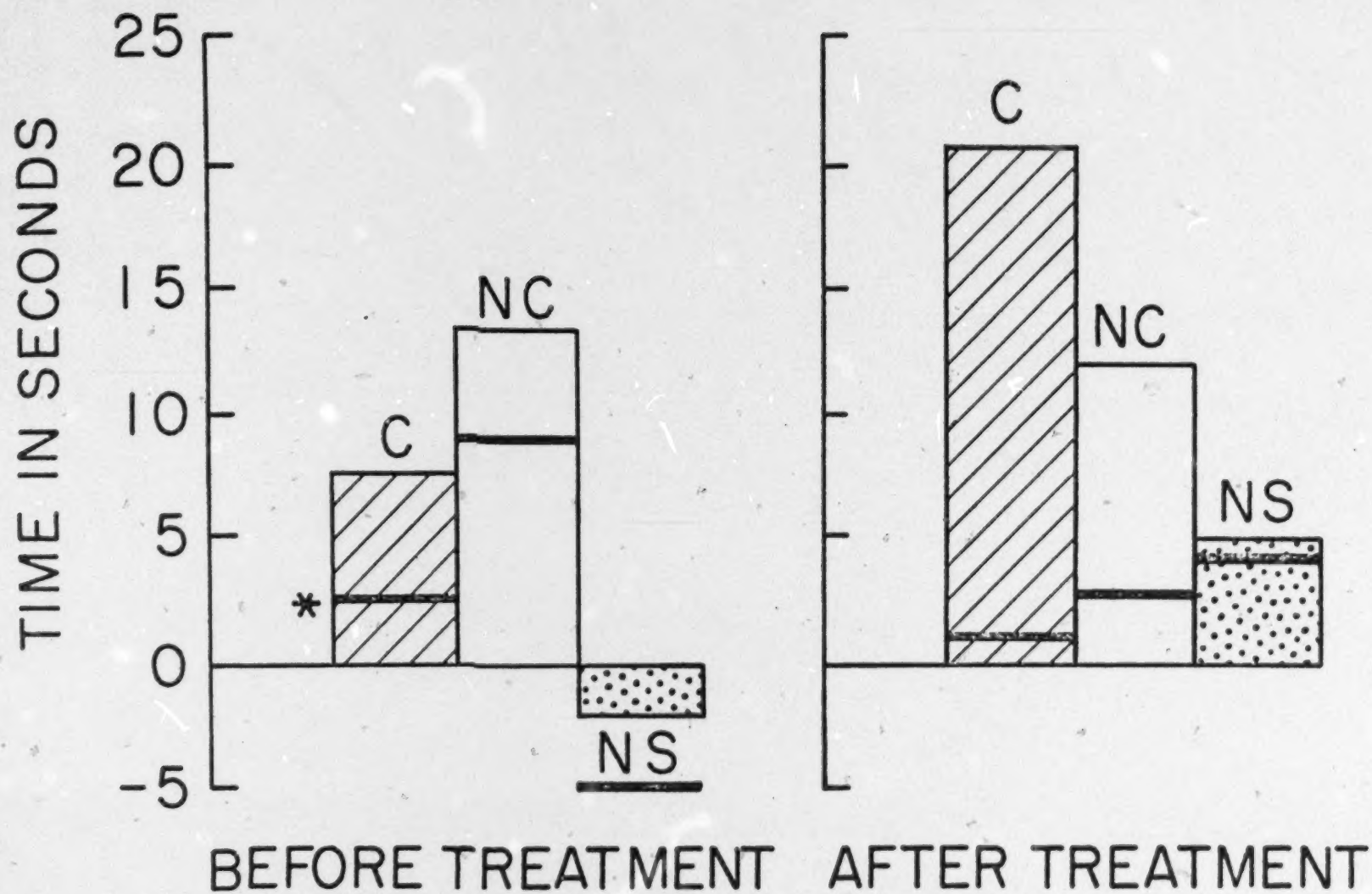
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MEAN RESPONSES PER MINUTE



BASLINE AND BLOCKS OF 3
CONDITIONING SESSIONS

22



* Lines indicate baseline performance.

